A STUDY OF OUTPUTS AND COST BENEFIT ANALYSIS FOR THE COASTAL REGION AVIATION PROGRAM

Calvin Bailey
South Carolina Forestry Commission
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Certified Public Manager Program
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PROBLEM STATEMENT

Since the use of the forest fire tower system was stopped in the early 1990's, the South Carolina Forestry Commission (SCFC) has relied on the public via 911 and the 1-800-777-FIRE number to report woods fires to initiate suppression action. The move from fixed tower detection to a call in detection method for forest fires was predicated with the change of demographics, the advancement of emergency communications in terms of 911 systems and the introduction of cell phones. The basic premise has always been that people if given a process will report wildfires to a central location will report at least 80% of the wildfires.

The use of light aircraft was introduced as a supplemental detection method to calling in these unreported wildfires. Many times planes are blamed for missed fires when actually the major responsibility of reporting wildfires rests solely with the public. The misconception exists from the fact that a study of the data has not been done to analyze the outputs of this fire management program. In this study, I will look at the outputs of this program to determine in spite of the high cost of aircraft did they provide the necessary return and meet the program expectations for it to be a viable program for the SCFC. It is my goal to conduct a complete analysis of the 2007 fiscal year of the aviation program for the Coastal Region. I'll do this by looking at the inputs and outputs of data provided from the Computer Aided Dispatch System (CADS) through reviewing the processes that involve state and contract leased aircraft.

HISTORY, EVOLUTION AND OVERVIEW OF AVIATION PROGRAM

The SCFC was established in 1927. From the beginning, an important part of the agency charge has been forest fire protection. In 1929, West Virginia Pulp and Paper

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Company now MeadWestvaco established a fire lookout tower near Summerville. It was the first tower in the state dedicated to protecting private woodlands. The first SCFC lookout tower was built in 1930 near Camden by the Civilian Conservation Corps. The tower network eventually included more than 130 towers. In 1950, the SCFC used light aircraft for forest fire detection for the first time. The SCFC lookout tower system was decommissioned in 1994. Forest fire detection is now handled through public reporting and supplemented by aerial surveillance through the use of light aircraft.

The SCFC operates, leases, and contracts aircraft for forest fire detection and suppression, insect and disease detection, storm damage evaluation, BMP monitoring and hurricane evacuation route monitoring . Light aircraft (Piper Super Cub, Cessna 172, 182, 185) are used for detection of wildfires and for assisting ground personnel and equipment in the suppression of wildfires. Helicopters from the Air National Guard and Greenville County Sheriff Department may be used in forest fire control and protection by utilizing helibucket or aerial ignition operations. Heavy aircraft may be contracted by the SCFC during the peak of the fire season as aerial tankers. The aerial tankers are capable of transporting liquid fire retardant, and delivering it on forest fires. Such aircraft are used primarily for initial attack on high value and high risk stands. Aerial tankers may be leased for a specified period of time with a daily standby fee and an hourly flying fee. A standard contract will allow for extensions to the contract period.

Aircraft presently operated by the SCFC are the property of the United States Federal Government and are obtained through the Federal Excess Property Program. A cooperative agreement with the USDA Forest Service allows the SCFC to operate aircraft subject to supervision by and under the guidelines of the USDA Forest Service.

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Additional light aircraft are leased on an hourly basis with SCFC pilots flying these leased planes. Under this agreement, leased aircraft are maintained by the leasing agent, but the rules and regulations which manage SCFC aircraft apply to leased aircraft. Additional aircraft and pilots are under contract to fly for the SCFC when needed. Currently only the Piedmont Region of the SCFC maintains a state aerial detection contract for forest fires. The Pee Dee Region and Coastal Region elected not to accept the aerial contracts for their respective bid lots this year. The reasons for not using the contracts will be discussed later in this study. Presently in our regional fire management program, the Coastal Region maintains four light aircraft a 1968 Piper Super Cub, a 1962 Cessna 185, and two 1967 Cessna T-41B which is the military version of the Cessna 172. A picture of each plane can be found in Appendix A.

DATA COLLECTION

The Computer Aided Dispatch System provided most all the data sets necessary to analyze this program except aircraft costs. The costs for regional aircraft are recorded in aircraft logs and then summarized into excel files which are used to track the annual costs associated with the operation of state aircraft. Costs used for contract leased aircraft were taken from field purchase orders where the hours flown and the state contract price of $105.00 per hour charge were paid on a monthly basis. The following data sets were used in this project:

1. number of fires in region with detection method
2. number of fires detected by contract aircraft
3. number of fires detected by state aircraft
4. number of days a plane flew in the fiscal year

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5. number of detections and method of detections for all recorded fires
6. costs for contract aircraft
7. costs for state aircraft
8. days planes flew and no fires recorded
9. number of recorded fires and cause of each fire
10. aircraft flight records for state and contract aircraft
11. number of detections when only contract aircraft flew
12. number of detections when only state aircraft flew
13. number of detections when state and contract aircraft flew
14. number of detections for each detection method for lightning caused fires

The yearly SCFC Annual Report which has a table that shows method of detection for all recorded fires presents some grim numbers when looking at aviation from such a generalized overview. All the data for this study was collected in this manner to breakdown the numbers to avoid a very general and quick look at the outputs of this program. Detection methods used in this study were summarized as public, 911, air state, air contract and SCFC. The detections listed under SCFC are for fires that were reported to dispatch by SCFC personnel. Pivot tables were used to calculate simple percentages for some of the data sets and the results are summarized in tables throughout this study.

The data was broken out into several different tables to show the relationships that coexist between all the values studied. Each data set is presented as a unique value that helps show the underlining meaning that exists in the overall data. Segregation of all the data sets along with going deeper in the numbers helped bring forth interesting ways to

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look at the values that dispel the misconception that light aircraft is not successful in detecting fires and lends a very low percent of success all the time.

DATA ANALYSIS

The SCFC suppressed 1072 wildland fires in the Coastal Region during the 2007 Fiscal Year.

TABLE 1: 2007 TOTAL FIRES AND DETECTION METHOD FOR ALL DAYS

HOW FIRE REPORTED	NUMBER OF DETECTIONS	PERCENT OF TOTAL
911	756	70
AIR CONTRACT	17	2
AIR STATE	70	7
PUBLIC	140	13
SCFC	89	8
TOTAL FIRES	1072	100

The above table shows an overview for the last fiscal year in terms of how the fire was reported to dispatch, the number of detections for each method and the overall percent of detection for the total fires. Definitions of how the fire reported can be found in Appendix C and a pie chart located in Appendix D illustrates a visual depiction of the values listed in Table 1. If you stopped at this point and did not look further into the data, the conclusion here would be that aviation plays a very insignificant role in the detection of fires. From here the data needs to be stratified even further to get the real picture. The large data set that was used to formulate Table 1 was all the fires recorded for the year and their detection method. That particular data set was adjusted by

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eliminating the days that the planes were not in the air and Table 2 was created that showed the days that planes actually flew.

TABLE 2: TOTAL DAYS THAT PLANES FLEW IN FISCAL YEAR

MONTH AND YEAR	TOTAL DAYS FLOWN
JULY 2006	21
AUGUST 2006	20
SEPTEMBER 2006	15
OCTOBER 2006	22
NOVEMBER 2006	27
DECEMBER 2006	19
JANUARY 2007	16
FEBRUARY 2007	22
MARCH 2007	29
APRIL 2007	27
MAY 2007	28
JUNE 2007	7
TOTAL DAYS	253

Assuming that there are a possible 365 fire days, the planes only flew 253 days last year meaning they were only responsible for detections during 69 percent of the days in the fiscal year. Reflecting back on the value of the data from Table 1, one hypothesis

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would suggest that the calculated percentages for aviation detections are not be a fair assessment of the situation. In other words, Table 1 was formulated based on all fires recorded on any fire day and not just the days that the planes flew when fires were recorded. Strictly based on the data up to this point, one would begin to understand that percent of fires detected might begin to increase once the data set is recalculated. Based on the above discussion, the Table 3 was created in order to summarize the fire year in regards to aviation.

TABLE 3: AVIATION FIRE YEAR

DESCRIPTION OF DAYS	NUMBER OF DAYS
DAYS FLOWN WITH RECORDED FIRES	204
DAYS FLOWN WITH NO RECORDED FIRES	49
DAYS WITH NO PLANES AND NO RECORDED FIRES	67
DAYS WITH NO PLANES AND RECORDED FIRES	45
TOTAL DAYS IN FISCAL YEAR	365

The data set that needs further analysis is the set of values associated with the days flown with fires. As the Table 3 shows, there were planes flying 204 days out of a total of 365 days. Additional analysis revealed that planes were in the air 56% of the year and found fires on 59 of the 204 days flown. The percentage works out that the planes found fires on 29% of the days they were flying. It should be noted that planes (state, contract or both) flew 145 days and were not credited with detections on those days. It should also be noted that there are times when planes and 911 or the public call fires into dispatch virtually simultaneously and the method of detection is not credited to the plane.

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This is not such a regular occurrence that it would distort the results of the analysis, but it is a situation that occurs and can reduce the number of detections credited to the planes. If you look at the number of detections by detection method for the 204 days flown, you will find that there is absolutely no change in the percent detections for this particular data set as compared to the yearly totals in Table 1. As Table 4 shows, the original hypothisis that the planes would increase their detections by narrowing down the data set by looking only at days flown proved to be incorrect as the percent of the total remained exactly the same.

TABLE 4: 2007 DETECTIONS FOR 253 DAYS FLOWN

HOW FIRE REPORTED	NUMBER OF DETECTIONS	PERCENT OF TOTAL
911	680	70
AIR CONTRACT	17	2
AIR STATE	70	7
PUBLIC	128	13
SCFC	78	8
TOTAL	973	100

One possible reason for this interesting phenomenon is that 91% of the total fires recorded for the year all occurred on the days that planes were flying for the purpose of aerial detection of fires and suppression action. This particular data analysis may not show that planes increased their detections based upon on lesser number of days flown, but it does seem to validate the decision to fly aircraft for the purpose of detecting fires on the days when most of the fires were expected and eventually recorded.

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The guide used daily by the Regional Aviation Manager and Assistant Regional Forester to help make the decision to fly planes on any given day is located in Appendix B. Only 99 fires were recorded on days when no planes flew this past fiscal year. Of course, if there had been fewer fires recorded during those 204 days flown, the percent of total for air contract and air state would have shown an increase in success of finding these fires aerially assuming the number of detections for the year remained the same. There are three additional data sets that require analysis within the 253 days flown last fiscal year. The three data sets are state and contract aircraft flying together (41 days), contract aircraft only flying (27 days) and state aircraft only flying (185 days). These three data sets are organized in the following tables (Tables 5, 6 & 7):

TABLE 5: BOTH STATE AND CONTRACT AIRCRAFT FLYING ON THE SAME DAY

HOW FIRE REPORTED	NUMBER OF DETECTIONS	PERCENT OF TOTAL
911	221	75
AIR CONTRACT	10	3
AIR STATE	21	7
PUBLIC	33	11
SCFC	13	4
TOTAL	298	100

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TABLE 6: CONTRACT AIRCRAFT FLYING ON A DAY WITHOUT STATE AIRCRAFT

HOW FIRE REPORTED	NUMBER OF DETECTIONS	PERCENT OF TOTAL
911	71	75
AIR CONTRACT	7	7
PUBLIC	6	6
SCFC	11	12
TOTAL	95	100

TABLE 7: STATE AIRCRAFT FLYING A DAY WITHOUT CONTRACT AIRCRAFT

HOW FIRE REPORTED	NUMBER OF DETECTIONS	PERCENT OF TOTAL
911	359	66
AIR STATE	46	8
PUBLIC	87	16
SCFC	53	10
TOTAL	545	100

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All calculations based on method of detection for the previous three tables are summarized in Table 8 for comparison. 911 and public are listed as "People" in Table 8. SCFC personnel were not included in the "People" category because, SCFC staff are not untrained in the methods of forest fire management. The Table 8 will summarize just how all the methods of detection compare to each other in terms of each data set analyzed.

TABLE 8: COMPARISON OF PERCENT OF TOTAL FOR METHODS OF DETECTION FOR EACH DATA SET ANALYZED

HOW FIRE REPORTED	TABLE 1	TABLE 4	TABLE 5	TABLE 6	TABLE 7
AIR CONTRACT	2%	2%	3%	7%	NA
AIR STATE	7%	7%	7%	NA	8%
PEOPLE	83%	83%	86%	81%	82%

Note that each table category listed above had a specific condition for the data set studied. It appears from the percent of total for each condition studied that the basic premise that people will report the vast majority of fires seems to hold true because all the percentages for the People category are above 80%. Given the fact that the public call in most of the wildfires, one would now need to determine what *supplemental* means when applying that term to aerial detection of forest fires. The value and understanding of these numbers as they apply to the success of the aerial detection part of a fire management program is very much guided by the perception of what each decision maker terms success in this program, what role do airplanes play in the overall scheme of things and what their definition is of *supplemental*. With each condition studied, the

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People category averaged 83% and throughout all the analysis the SCFC category averaged 8%. The aircraft provided supplemental detection at the rate of 9%.

There are nine nationally recognized wildland fire causes. A cause is assigned to a wildland fire after it is contained and controlled. This data was reviewed here just to look at one final data set where aircraft play a significant part in the role of detection. During certain times of the fire year when thunderstorm activity increases in our local weather patterns, lightning can become a factor as an ignition source. There were 44 lightning caused fires in the Coastal Region last year and this cause accounted for 4.2% of all the fires. Table 9 below shows how lightning fires were reported in the Coastal Region last year.

TABLE 9: LIGHTNING CAUSED FIRES IN THE COASTALREGION

HOW FIRE REPORTED	NUMBER OF DETECTIONS	PERCENT OF TOTAL
911	23	52
PUBLIC	6	14
SCFC	8	18
AIR STATE	7	16
TOTAL	44	100

When a lightning fire goes unreported, aircraft activity and detection routes for that day are questioned heavily for the miss. Many times planes are asked to fly on days when lightning fires may have occurred and the days thereafter. These are generally days when weather patterns are not conducive to successfully finding these fires. Hazy summer days usually equate to very poor visibility. However, using data obtained from

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the Bureau of Land Management Fire Management Information Lightning internet site during times of lightning activity, negative and positive strikes are recorded within areas of interest on local maps. The latitude and longitude coordinates for each strike is determined and combined with precipitation shape files from the national weather service to create a data set that is then downloaded into an ARCGIS 9 application to assist in pinpointing areas where dry lightning (< .25 inches of rain) may have occurred.

This process was used this last fiscal year with some success in determining areas for the aircraft to fly. Aircraft found 16% of the lightning fires for the year and it would probably be fair to say that these fires were found in remote areas where people do not readily travel. However, even with this fire cause the People still called in 68% of these ignitions.

IMPLEMENTATION PLAN

A solution was already implemented before this study was completed and the decision to make a business change was based solely on economics. The air detection contracts for the Coastal Region and Pee Dee Region were not accepted after the bid process was completed because of very high bid prices. The price per hour increased from $105.00 per hour to $219.50 per hour for the Coastal Region. The bid for the Pee Dee Region topped out at $225.00 per hour. Based on the data analysis for this study, the decision to move away from contract aerial detection appears to be a good cost-saving decision since last fiscal year cost of contract aerial detection for the Coastal Region was $55,461. The contract planes flew 528 hours and only detected 17 fires last fiscal year which converts to a cost of $3,262.41 per fire. The four state planes assigned to Coastal Region flew 859 hours at a total cost of $121,868 last fiscal year. The total cost figure

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included insurance, normal operation costs, a new engine for one plane and the hourly pay for the temporary pilots. The hourly rate for the temporary pilots is $15 per hour or $20 per hour based on fire experience. The average operation cost last fiscal year for all four planes was either $139.37 per hour or $144.37 per hour based on which pilot was flying the plane. During their flights, the state planes detected 70 fires last fiscal year which converts to $1,740.97 per fire and is just slightly over half the cost per fire for contract planes. In addition, state planes during their operation last fiscal year were multi-tasking on each flight as they would fill both detection and suppression roles whereas the contract planes were not allowed to do suppression unless a certified SCFC Aerial Observer was in the plane. Even though the final results from the data analysis showed that aircraft are providing supplemental detection at the 9-10% level, the decision to discontinue using contract aircraft in two regions was the correct decision and t is justified by the data in this study. The other part of the solution that was implemented to counteract the loss of contract aerial detection was the decision to hire, in each effected region, another full time pilot and use more temporary pilots to fly state planes to do aerial detection.

Evaluation Method

The exact process used in this report to study outputs and costs associated with the Coastal Region Aviation Program could be used in the other two regions to determine efficiency in regards to the outputs from the detection data and evaluate the costs associated with aviation. Since the aerial contract bid was accepted in the Piedmont Region, this study would be a great method to break down the data in that region to study the effectiveness of contract aircraft and do cost comparisons to determine if the plan

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implemented to stop using contract aerial detection in the other two regions would be the correct decision for Piedmont Region. Presently, the data sets collected and data analysis used in this study would function nicely as an evaluation method from this point forward for reviewing the Piedmont Aviation Program and determining the success of the state planes since assuming all the responsibility of aerial detection in the Coastal and Pee Dee Regions.

Summary and Recommendations

Several key findings of this project positively confirm that many of the historical changes made in the process of how fires are detected and reported to our dispatch system were in fact good sound decisions. In the early years after switching from towers to people and planes, expectations were high that planes would find many of the fires and the role of supplemental aerial detection was forgotten in the overall process. The planes were blamed for missed detections when in fact the numbers would show that the fires they missed, statistically speaking, may not have been their fire to find after all. This study supports that airplanes actually do an adequate job of supplementing the detections of fires that the public does not report and the percentages in regard to method of detection statistically support the notion that people will in fact call in most of the fires.

Another key finding from this project revealed that even though planes during their scheduled flights did log some days with no fires detected, it was found that the planes were flying 91% of the times when the region was experiencing fire activity. In other words, based on potential fire danger, expected fire occurrence and predicted fire behavior, the numbers support that the decision to fly planes on these days were correct and in fact the planes flew most of the fire days in the region. Based on the key findings

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of this report, there are a few recommendations for future operations that should be considered. First, because the percentages are identified on just how many fires people will report versus the planes, the leadership should consider routes for the planes to fly in specific geographic locations where people do not travel on a regular basis. The underlying concept here is if a fire goes unreported in the areas where the planes are not required to fly, then the routes should not be adjusted based on a missed detection in an area where there is a high confidence level that the public will report the fire. The missed detection would only be questioned and evaluated if the fire went unreported on a permanently designated detection route.

A second recommendation is to continue business as usual for aviation operations with an added emphasis on studying work processes that involve airplanes. By using aircraft data to determine realistic expectations and data based decisions for future operational changes, the conclusions reached from the methods used in this study indicates that aviation has a clear and significant role in the detection and suppression of wildfires. One very important final conclusion is for anyone evaluating the outputs of an aviation program to always consider some alternate thinking patterns in regards to data collection and data analysis of aircraft activity as it relates to aerial detection of wildfires. The alternative thought processes used in this study should promote the idea that by listening to the voice of the process and by doing a thorough data analysis one can gain a proper perspective about what the real expectations should be for aircraft as it relates to successful aerial detection of fires. The recommendations of this study in combination with the complete data analysis process used should insure that all the outputs and costs

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of an aviation program be evaluated fairly as to the role of aircraft in the detection and suppression of the wildfires of this state.

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APPENDIX A

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APPENDIX B

SCFC Coastal Region Weather & Flight Schedule

January 2008 (FY 2007-08)

	Fire Danger		AM Wx Forecast (NWS)						PM Wx Walterboro			Planes Flown & Pilot Last Name			
Day	Edisto	Santee	RH	Wind (mph)	Light-ning	Condi-tion #	Num of Planes	Actual Wx	RH	Wind (mph)	KBDI	N10044 C-185	N62219 T-41B	N98188 T-41B	N4340Z Cub
1															
2															
3															
4															
5															
6															
9															
10	Low	Low	58	3	none	3	standby	showers	58	6	349				
11	Low	Low	57	9	none	4	none	rain	74	13	356				
12	Low	Low	57	3	none	3	none	showers	63	3	309				
13	Low	Low	57	3	none	3	none	fog	20	4	311				
14															

SCFC COASTAL REGION
Aircraft Scheduling Chart

MAXIMUM SUSTAINED WIND SPEED (mph)								
Min Rel Hum	<5	5 to 12		>12				
		KBDI		KBDI		Fire Danger		
		<500	>500	<500	>500	Low	Mod	High
<30	4	5	6	6	7	6	6	7
30-60	3	4	na	6	7	6	6	7
>60	2	3	na	3	3	na	na	na

NOTES: 1) Disregard KBDI <500;

2) unusual thunderstorm or arsonist activity considered case-by-case.

CONDITION NUMBERS:

1. No scheduled flights -- conditions are wet and fire occurrence is unlikely.
2. 1 SCFC aircraft on standby to fly only if a specific request comes in.
3. PM detection with 1 aircraft per region.
4. PM detection with 2 aircraft per region.
5. PM detection with 2 aircraft per region & 1 suppression aircraft per region.
6. PM detection and suppression with multiple aircraft per region.
7. AM & PM detection & suppression with multiple aircraft per region.

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APPENDIX C

How Fire Reported Definitions

911: Fires that are reported to SCFC Dispatch from a 911 emergency service dispatcher from each county in the Coastal Region.

Air Contract: Fires that are reported to SCFC Dispatch from a contract plane hired to do contract aerial detection of fires in the Coastal Region.

Air State: Fires that are reported to SCFC Dispatch from a state maintained airplane directed to do aerial detection and suppression on Fires in the Coastal Region.

Public: Fires that are reported to SCFC Dispatch from a caller that uses the local dispatch number or calls from the 1-800-734- BURN number.

SCFC: Fires that are reported to SCFC Dispatch from employees of the SC Forestry Commission.

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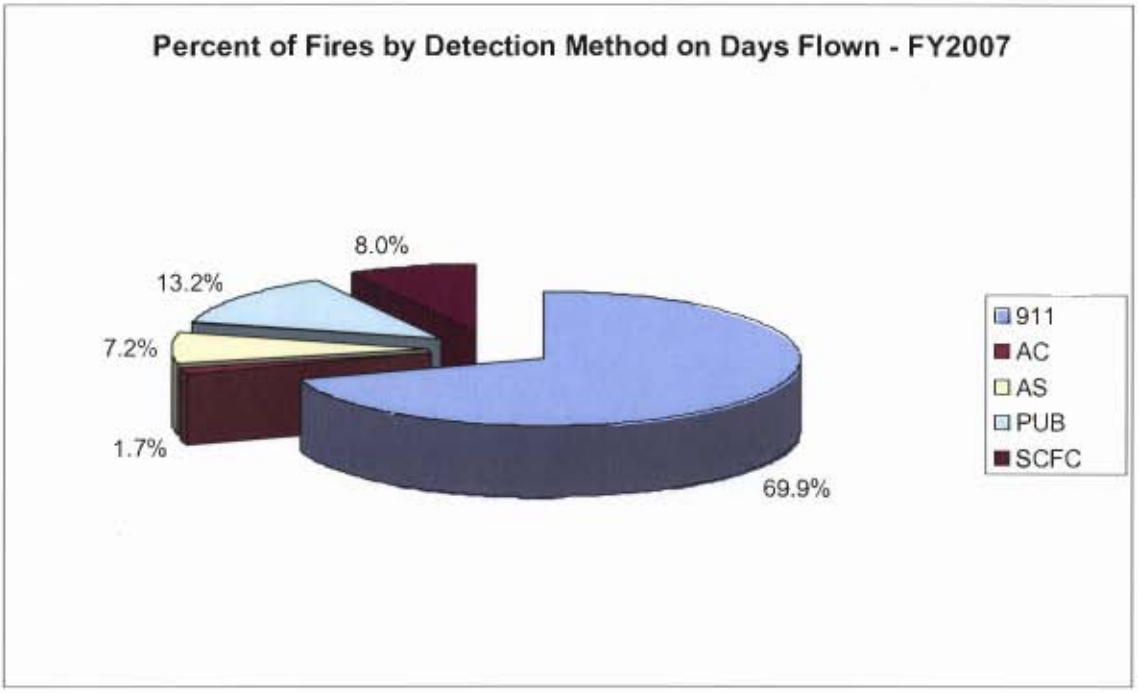
APPENDIX D



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